

THE FLORIDA STATE UNIVERSITY

COLLEGE OF ENGINEERING

**PHYSICOCHEMICAL AND HYDRODYNAMICS ASPECTS OF
ELECTROKINETICS IN SOIL REMEDIATION**

[A Study Based on Fundamental Principles and Modeling Approaches]

By

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ABSTRACT

The presence of contaminant sites on the earth's surface is quite common and the need for their cleaning is huge and urgent. From the many technology efforts made to avoid the spreading of contaminants such as heavy metals the application of an electrical field on a soil matrix has given encouraging results. Several reports have described the goodness of electrokinetic-remediation as follows: it can be applied *in situ*, no excavation is necessary, it targets specific contaminants, and it works in low permeability soils. In fact, these are the reasons why applying electrical fields has been one technology pathway that has received so much attention in recent years. Although electrokinetic soil remediation has remained a promising technology, the drawbacks in field testing have suggested that fundamental research is still needed to fully understand the process. In effect, the analysis of the porosity, in conjunction with a more realistic set of transport forces, i.e. electroosmosis, electromigration, buoyancy and advection, is still missing in the literature and therefore it is the subject matter of this research. Consequently, this work concentrates on the analysis and comparison of predictions of at least three main aspects of electroremediation, i.e., heat transfer, electrostatics, and hydrodynamics. Overall, the comparison of transport forces is based on the use of different geometrical models to bring the role of porous media aspect and electrode shape into the analysis. Additionally, a new solution strategy is proposed for the differential equations of the electrostatic potential based on the Debye-Hückel approximation. From the study, the collected information is useful to identify further efforts to be made in investigation and to delineate a systematic approach for a more rigorous description of the electroremediation process. Implications for design of devices and cleaning strategies are also included. The knowledge obtained in this analysis is useful to promote a deeper understanding of the behavior of the system, and to lead to important guidelines for improving cleaning efficiency in a given application.